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(54) Title: BEVERAGE INFUSION PACKAGES AND MATERIALS THEREFOR

(57) Abstract: A non-woven porous, fibrous tissue for use in producing beverage infusion packages comprises cellulose fibres and polylactic acid (PLA) fibres to improve repulpability of waste materials.

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BEVERAGE INFUSION PACKAGES AND MATERIALS THEREFOR

The present invention relates to porous, fibrous web materials of the heat seal type for use in producing beverage infusion packages (e.g. tea bags, coffee bags and the like) as well as to beverage infusion packages produced using such materials.

Beverage infusion packages comprise a particulate beverage precursor material, e.g. tea leaves or ground coffee, in a bag, sachet, pouch or the like (all conveniently referred to herein as a bag) of a porous, fibrous (usually cellulosic) material. This material typically has a basis weight of 10 to 30 g m⁻² and is often referred to as "tissue" or "tissue paper".

To produce a beverage, the package is infused with hot water. This may be done, for example, by immersing the package in hot water, pouring hot water onto the package, or heating water and the bag in a microwave oven.

The infusion package may be of a size, and contain an amount of the beverage precursor material, so as to be intended for producing a single cup of the beverage. Alternatively the package may be of a "catering size" and as such intended to produce a plurality of servings of the beverage. Such a "catering size" package may for example contain ground coffee as the beverage precursor material and be used in a commercial coffee-making machine.

"Heat seal" tissue usually (but not necessarily) comprises two or more layers wet-laid in succession one on top of the other. One layer incorporates thermoplastic fibres (e.g. polypropylene) and the other incorporates only thermally inactive materials. The tissue will generally also incorporate a wet strength agent and is typically manufactured by a wet laid process on an inclined wire paper making machine.

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A beverage infusion package is produced from the heat seal such tissue by forming the bag such that layers of the tissue incorporating thermoplastic fibres are juxtaposed and then heat sealed.

There are currently available many thermoplastics which can be used as fibres for producing heat seal tissue and, when used for producing beverage infusion packages, give more than adequate performance. However the tissue has a disadvantage in that the waste material ("broke") generated during manufacture of the tissue (e.g. as a result of reeling operations) cannot successfully be reused. This is because the tissue will not break down during standard alkaline conditions used in fibre recovery processes. To recover a proportion of the cellulose fibre, non standard chemicals and high levels of mechanical energy have to be used, and these result in a low grade recovered fibre source, still containing thermoplastic material, which is undesirable. Also the fibre length of the resultant material is dramatically reduced from a virgin mean fibre range of typically 3.5 - 6 mm down to 0.96 - 1.65 mm. This reduction in fibre length and retention of thermoplastic material within the "broke" results in only a small level of "broke" being able to be accommodated within the tissue. This is due to the very short fibre length reducing the pore size of the web, as it forms on the moving belt of the paper machine, which negatively impacts on the water removal process, production rate, costs and physical properties of mechanical strength and seal strength. For these reasons, the "broke" is predominantly disposed of in landfill sites or by incineration.

To the extent that the "broke" is disposed of in a land fill site, there is an additional disadvantage in that the thermoplastic fibres are generally not biodegradable and therefore remain in the environment. This disadvantage also applies to the disposal of used beverage infusion packages (produced from the tissue) in land fill sites.

It will thus be appreciated that the inability to recycle "broke" in the production of heat seal tissue gives rise to two disadvantages. Firstly, the need to

produce the heat seal tissue from "broke" free virgin materials increases cost. Secondly, the need to dispose of the broke give rise to environmental disadvantages, particularly in the case of disposal in a land fill site. The ability to recycle the "broke" would have a positive impact both on the cost base for the production of tissue and for the environment but due to the above mentioned limitations these advantages are not currently realised.

It is therefore an object of the present invention to obviate or mitigate the above mentioned disadvantages.

According to the present invention there is provided a non-woven porous, fibrous tissue for use in producing beverage infusion packages, wherein said tissue comprises fibres produced from polylactic acid (PLA).

According to a second aspect of the invention there is provided a beverage infusion package comprising a bag of a non-woven porous, fibrous tissue as defined in the previous paragraph, and a beverage precursor material contained within the bag.

The PLA fibres in the tissue are thermoplastic and serve as heat seal fibres for the purposes of thermally bonding two layers of the tissue together.

We have found that the inclusion of PLA fibres in tissue to be used for producing beverage infusion bags significantly improves the "re-pulpability" of the tissue. Material produced using PLA will re-pulp under alkaline condition as the PLA readily hydrolyses. This method of removing the PLA fibres fits with the process for removing the typical wet strength systems used in the production of the aforementioned porous tissue. The ability to "peel" the PLA fibres away from the de-wet strengthened cellulose matrix enables the fibre length of the recovered pulp to be maximised to a typically mean fibre range of 2.5 - 3.5 mm. This increase in overall mean fibre length range and the removal of thermoplastic fibres enables more waste material to be utilised in both the "parent" product, without detracting from product

performance or production efficiencies, and other non related NHSTB products without the problem of inclusion of a small percentage of thermoplastic from the inclusion of broke. These factors result in a significant reduction in the requirement for the use of landfill or incineration of waste "broke" materials.

Furthermore, as is known, PLA polymers degrade in the environment into lactic acid (monomer). Thus tissue disposed of to a typical landfill site (e.g. in the form of a "used beverage infusion package") will ultimately completely degrade. In this way the impact on the environment is significantly reduced compared to the current thermoplastic containing materials.

The production of polylactic acid (PLA) for use in forming the fibres employed in this invention is described for example in US-A-5 142 023 (Cargill, Incorporated). Briefly however PLA is produced by condensation of lactic acid. By adjusting the ratio of the D(+) and L(-) isomers used in the polycondensation reaction, it is possible to significantly affect the degree of crystallinity of the PLA and therefore adjust properties such as melting/softening point. In broad terms a 100% L(-) isomer would give a melt flow temperature of circa 170°C, while a combination of 88% L(-) and 12 % D(+) isomers would produce a melt flow value of circa 120°C. PLA fibres for use in the invention may be obtained from Unitika Fibre of Japan under the trade name of Terramac.

Beverage infusion packages (e.g. tea bags) may be produced from tissue in accordance with the invention on standard converting machinery at throughput rates commensurate with those achieved using conventional tissue with seals of adequate strength.

The PLA fibres will preferably have a fibre length of 2mm to 8mm, more preferably 4mm to 6mm, and ideally about 5mm.

Preferably the PLA fibres are from 0.9 dcTex to 4.4 dcTex, more preferably from 1.4 dcTex to 3.3 dcTex, even more preferably 1.7 dcTex to 2.6 dcTex and most preferably from 1.9 dcTex to 2.2 dcTex for optimum fibre coverage.

The PLA fibres preferably melt (soften) at a temperature of 140-175°C and have an MFI (MFR) value of 10 - 14 (230°C, 2.16 kgs).

The PLA fibres may be single component fibres. It is however also possible for at least a portion of the PLA fibres to be bicomponent fibres comprised of a PLA core and an outer PLA sheath of significantly lower melting point than the core. Thus, for example, the PLA core may have a melting point of about 260°C whereas that of the PLA sheath may be 105°C to 175°C. It is possible that the bicomponent fibres may be the sole PLA fibres in the tissue. In this case, the sheath of the bicomponent fibres will generally be such as to melt (soften) at a temperature of 140-175°C and have an MFI (MFR) value of 10 - 14 (230°C, 2.16 kgs), i.e. the same properties for the single component, heat seal PLA fibres. It is however also possible that the tissue incorporates single component PLA fibres as the heat seal fibres and bicomponent fibres having a sheath with a lower melting (softening) temperature than the single component fibres. Thus, in this case the sheath of the bicomponent fibres may have a melting/softening temperature in the range 105°C to 165°C but lower than the melting (softening) temperature of the single component fibres. In all cases, the core of the bicomponent fibres may have a melting (softening) temperature of about 260°C with the core providing for added strength of the tissue.

If PLA bicomponent fibres are incorporated in the tissue then these may be thermally bonded to each other at the cross-over points of these fibres during manufacture of the tissue (see *infra*) to give a significant increase in both dry and wet tensile strength, again with no affect on total tissue re-pulpability and product biodegradability. The incorporation of bicomponent (sheath and core) fibres in the tissue allows optionally for a string and tag to be thermally bonded to the beverage infusion bag.

Tissue in accordance with the invention will generally have a basis weight of 10 to 50 g m⁻² more preferably 10 to 30 g m⁻², even more preferably 10 to 20 g m⁻² and still more preferably 10 to 18 g m⁻², e.g. 12 to 17 g m⁻². For preference the tissue will be a wet-laid material although production of the tissue as a dry laid material is also possible.

A heat seal tissue in accordance with the invention may comprise only a single layer which is the thermally active layer and which incorporates the PLA fibres and also cellulosic material as conventionally used in the formation of tissue. The heat seal tissue may also comprise an insulating layer incorporating only thermally inactive fibres.

It is preferred that the heat seal tissue incorporates a total of 10% to 40%, more preferably 15% to 35% by weight of the PLA fibres based on the weight of the thermally active layer. If the PLA fibres are comprised of both single component and bicomponent fibres then it is preferred that 60-80% by weight of the PLA fibres are single component fibres and correspondingly 20-40% by weight (of the PLA fibres) are bicomponent fibres.

Cellulosic fibres for incorporation in the thermally active layer may be conventionally woody and/or non-woody materials, e.g. Manila hemp, sisal, jute, bleached and unbleached soft wood and hard wood species. Alternatively or additionally the cellulose fibres may be of a regenerated or reconstituted cellulose such as viscose rayon or lyocell. Typically the cellulosic fibres in the thermally active layer will have a length of 1 mm to 5 mm.

Cellulosic fibres preferably provide 30% to 65% by weight of the thermally active layer.

It is preferred that the tissue incorporates 1% to 20%, more preferably 7% to 15% by weight of floc based on the weight on the thermally active layer.

Flocs for use in the invention are heavily fibrillated fibres and for materials produced by a wet-laying technique on a papermaking machine (e.g. an inclined wire machine) act as an effective binder to provide "classic" wet web strength prior to drying and removing the non-woven tissue from the inclined wire forming fabric and provide dry web strength after drying the non-woven web. The floc will generally have a fibre length within the range 0.1mm to 1.5mm but preferably about 1.0mm. At this fibre length, the area coverage of the fibre is significantly increased, compared to a typical fibrillated 5mm fibre, by a combination of internal and external "cleaving" of the fibre wall surface. Generally the floc will have a SR value in the range 60° to 100°, more preferably 70° to 95°.

The heat seal tissue may optionally comprise both a thermally active layer (i.e. one incorporating the heat seal fibres) and a thermally inactive or insulating layer. In this case, the former preferably comprises 60% to 80% by weight of the heat seal tissue and the latter 20% to 40% on the same basis. More preferably the former comprises 60% to 75% and the latter 25% to 40% on the same basis. Most preferably the heat seal tissue comprises 65% to 75% by weight of the thermally active layer and 25% to 35% by weight of the insulating layer.

If the heat seal tissue incorporates a thermally inactive layer then this preferably comprises natural cellulosic fibres. Although it can also contain regenerated cellulose such as viscose rayon or lyocell in the order of 70% to 95% by weight of wood pulp and 5% to 30% by weight of synthetic cellulose, most preferably about 85% by weight wood pulp and about 15% by weight synthetic cellulose.

For the insulating layer, the synthetic cellulose fibres are preferably shorter than those in the thermally active layer and may have a length of 0.5mm to 5mm, preferably 1mm to 3mm.

Tissue in accordance with the invention is most preferably produced by wet-laying employing technique well established in this field. The tissue may for example be produced on an inclined wire papermaking machine.

If the tissue comprises a thermally active layer and an insulating layer then these may be laid in either order. If biocomponent fibres are included then they may be thermally bonded during drying of the tissue on the paper making machine giving a significant increase in both dry and wet tensile strength.

The dry tensile strength of a wet laid tissue can be increased by coating (e.g. using a size press, blade coater, gravure printing press etc.) with a solution of a starch, or poly(vinyl)alcohol (95 - 99% hydrolysed) or latex (preferably a food approved SBR) or a cellulose ether, e.g. selected from methyl cellulose, ethyl cellulose, hydroxyethyl cellulose, propyl cellulose, hydroxypropyl cellulose but most preferably carboxymethyl cellulose, at a level of 0.5% to 3%, more preferably 1% to 2% by weight of the tissue, to improve mechanical strengths.

Wet strength may be enhanced by the use of melamine.

Tissue in accordance with the invention may alternatively be produced by a dry-laying technique, in which case it will be preferred that the tissue incorporate biocomponent fibres.

Beverage infusion packages (e.g. tea bags or coffee bags) may be produced from tissue in accordance with the invention on standard converting machinery at throughput rates commensurate with those achieved using conventional tissue.

The invention is illustrated by the following non-limiting Examples.

Example 1

A wet-laid heat seal tissue having a basis weight of 16.5 g m^{-2} was prepared from a furnish comprising

<u>Component</u>	<u>% by weight</u>
Manila fibres (5mm, 2.4 dcTex)	41.0%
¹ PLA fibres (5mm, 2.2 dcTex)	21.0%
Bleached Softwood Floc	33.0%
Moisture	5.0%

¹ ex Unitika of Japan under the trade name Terramac

The fibrous web was treated with 3.0% by weight melamine applied at the wet end of the paper machine.

The resultant product converted at satisfactory speeds on standard tea-bag manufacturing machinery and gave tea bags with adequate seal strengths.

Example 2

A wet-laid heat seal tissue having a basis weight of 16.5 gsm was prepared from a furnish comprising

<u>Component</u>	<u>% by weight</u>
Manila fibres (5mm, 2.4 dcTex)	40.0%
¹ PLA (5mm, 2.2 dcTex)	10.0%
² PLA Sheath and Core fibres (5mm, 2denier)	15.0%
Lyocell fibres (3mm, 2.4 dcTex)	21.0%
Bleached Softwood Floc	9.0%
Moisture	5.0%

Unitika of Japan under the trade name Terramac Unitika of Japan under the trade name Terramac

The melting point for the single PLA fibre was 170°C

The melting points for the bi-component PLA fibre were 130°C sheath and 170°C core

The product obtained also again converted well on standard tea bag manufacturing apparatus to give tea bags with adequate seal strength to with stand brewing by microwave method.

Example 3

The tissue produced in Examples 1 and 2 was under laboratory conditions to replicate the typical production scale re-pulping process. The re-pulping procedure was also carried out on a standard polypropylene-containing tissue.

The results obtained were as shown in Table 1.

Table 1

BROKE TREATMENT OF MATERIAL			
BROKE CONDITION	CHEMICAL	TEMPERATURE	SOAK TIME
	4% w/w NaOH	80°	60 MIN
TEST METHOD	WET TENSILE Before Treatment	WET TENSILE After Treatment	% Difference
PLA (Example 1&2) No Mechanical Action	15 kN/m	0.065kN/m	- 99.5
Std Polypropylene Control No Mechanical Action	16 kN/m	9.1 kN/m	- 43.1
Std Polypropylene Control With Mechanical Action Beaten under full load 1 hour	16 kN/m	0.06kN/m	-99.6

It will be seen from Table 1 that the wet strength tensile reduction of the PLA material was the same as for the polypropylene control thus confirming the removal of the melamine wet strength chemical. However, in the case of the control, the polypropylene "web" was still place and the tissue would only disperse with significant mechanical action, which was supplied by traditional, Hollander Beta under full load for 1 hour. In contrast, the PLA material readily dispersed without mechanical action

The impact on the quality of the final "broke" material due to the need for significant mechanical action to disperse the polypropylene containing web can be seen from table 2 which compares the initial (Virgin) product fibre lengths to the chemical and mechanically treated fibre lengths of a "broke" treated product web, for both the PLA and polypropylene containing materials.

Table 2

FIBRE LENGTH ANALYSIS OF PRODUCT BY KAJAANI 100			
Weighted AVE	PLA / PP Initial Stock Fibre length mm	PLA Broke Treated Fibre length mm	POLYPROPYLENE Broke Treated Fibre length mm
D1	0.58	1.04	0.36
Q1	1.15	1.44	0.59
Q2	3.07	4.33	0.96
Q3	4.99	4.92	1.49
D9	5.33	5.22	2.18
AVE	3.07	3.39	1.14
Wt AVE	4.26	4.25	1.65

Claims

1. A non-woven porous, fibrous tissue for use in producing beverage infusion packages, wherein said tissue comprises cellulose fibres and polylactic acid PLA fibres to improve re-pulpability of waste materials.
2. A tissue as claim 1 wherein the PLA fibres have a fibre length of 2 mm to 8mm.
3. A tissue as claimed in claim 2 wherein the PLA fibres have a fibre length of 4mm to 6mm.
4. A tissue as claimed in claim 3 wherein the PLA fibres have a fibre length of about 5mm.
5. A tissue as claimed in any on claims 1 to 4 wherein the PLA fibres are from 0.9 dcTex to 4.4 dcTex.
6. A tissue as claimed in claim 5 wherein the PLA fibres are from 1.4 dcTex to 3.3 dcTex.
7. A tissue as claimed in claim 6 wherein the PLA fibres are from 1.7 dcTex to 2.6 dcTex.
8. A tissue as claimed in claim 7 wherein the PLA fibres are from 1.9 dcTex to 2.3dcTex
9. A tissue as claimed in any one of claims 1 to 8 having a basis weight of 10 to 50 g m⁻².
10. A tissue as claimed in claim 7 wherein the basis weight is 10 to 30 g m⁻².

11. A tissue as claimed in claim 8 wherein the basis weight is 10 to 20 g m⁻².
12. A tissue as claimed in claim 9 wherein the basis weight is 12 to 17 g m⁻².
13. A tissue as claimed in any one of claims 1 to 12 wherein the heat PLA fibres comprise 10% to 40% by weight of the thermally active layer.
14. A tissue as claimed in claim 13 wherein the PLA fibres comprise 25% to 35% by weight of the thermally active layer.
15. A tissue as claimed in any one of claims 1 to 14 wherein at least proportion of the PLA fibres are single component fibres.
16. A tissue as claimed in claim 15 wherein said single component PLA fibres melt (soften) at a temperature of 145-175°C.
17. A tissue as claimed in any one of claims 1 to 16 wherein at least a proportion of the PLA fibres are bicomponent fibres comprised of a PLA core and lower melting PLA sheath.
18. A tissue as claimed in claim 17 wherein the thermally active layer comprises single component PLA fibres and bicomponent PLA fibres.
19. A tissue as claimed in claim 18 wherein the single component fibres have a melting (softening) point of 145 to 175°C and the bicomponent fibres have a sheath with a melting (softening) temperature in the range 105°C to 165°C but lower than the melting (softening) temperature of the single component fibres.

20. A tissue as claimed in any one of claims 1 to 19 additionally comprising an insulating layer incorporating only thermally inactive fibres.

21. A tissue as claimed in claim 20 wherein the thermally active layer comprises 65% to 97% by weight and the insulating layer comprises 3% to 35% by weight, the percentages being based on the weight of the tissue.

22. A tissue as claimed in claim 21 wherein the thermally active layer comprises 79% to 93% by weight and the insulating layer comprises 7% to 21% by weight, the percentages being based on the weight of the tissue.

23. A tissue as claimed in claim 22 wherein the thermally active layer comprises 83% to 90% by weight and the insulating layer comprises 10% to 17% by weight, the percentages being based on the weight of the tissue.

24. A tissue as claimed in any one of claims 20 to 23 wherein the insulating layer comprises wood pulp and lyocell or viscose rayon fibres.

25. A tissue as claimed in claim 24 wherein the insulating layer comprises 70% to 95% by weight wood pulp and 5% to 30% by weight lyocell or viscose rayon.

26. A tissue as claimed in claim 23 wherein the insulating layer comprises about 100% by weight wood pulp.

27. A tissue as claimed in any one of claims 20 to 26 wherein the cellulosic fibres of the insulating layer have a length shorter than those of the thermally active layer.

28. A tissue as claimed in any one of claims 20 to 27 wherein the cellulosic fibres of the insulating layer have a length of 0.5mm to 5mm.

29. A tissue as claimed in claim 38 wherein the cellulosic fibres of the insulating layer have a length of 1mm to 3mm.
30. A beverage infusion package comprising a bag of a tissue as claimed in any one of the previous claims and a beverage precursor material contained within the bag.
31. A package as claimed in claim 30 which is a tea bag.
32. A package as claimed in claim 30 which is a coffee bag.

INTERNATIONAL SEARCH REPORT

Intern. Application No

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 D21H13/24 D21H27/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 D21H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAPERCHEM, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

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T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

Z document member of the same patent family

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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